

*Volume 27*

January, 1941

*Number 1*

# Lubrication

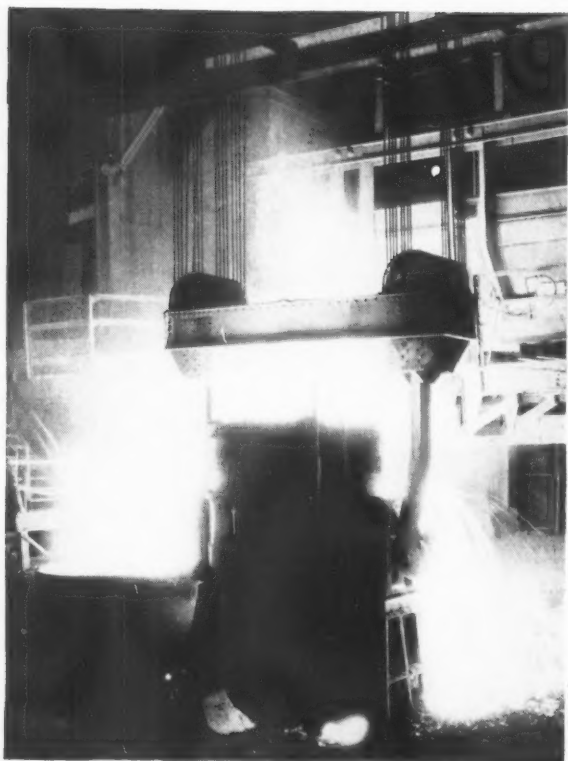
A Technical Publication Devoted to  
the Selection and Use of Lubricants

THIS ISSUE

Temperature Maintenance



PUBLISHED BY  
**THE TEXAS COMPANY**  
TEXACO PETROLEUM PRODUCTS



# A HOT SPOT for WIRE ROPE

Not only on wire rope in severe steel plant service, but on many other high temperature jobs, ideal lubricants are Texaco.

## They Prefer TEXACO

- ★ MORE SCHEDULED AIRLINE MILEAGE WITHIN THE U.S. AND TO OTHER COUNTRIES IS FLOWN WITH TEXACO THAN WITH ANY OTHER BRAND.
- ★ MORE BUSES, MORE BUS LINES AND MORE BUS-MILES ARE LUBRICATED WITH TEXACO THAN WITH ANY OTHER BRAND.
- ★ MORE STATIONARY DIESEL HORSEPOWER IN THE U.S. IS LUBRICATED WITH TEXACO THAN WITH ANY OTHER BRAND.
- ★ MORE DIESEL HORSEPOWER ON STREAMLINED TRAINS IN THE U.S. IS LUBRICATED WITH TEXACO THAN WITH ALL OTHER BRANDS COMBINED.
- ★ MORE RAILROAD ROLLING EQUIPMENT IN THE U.S. IS LUBRICATED WITH TEXACO THAN WITH ANY OTHER BRAND.
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THE HANDLING of molten metal subjects wire rope to the toughest kind of service. Prolonging its life in such service demands a lubricant supremely heat-resistant.

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*Texaco Crater* in high temperature service both lubricates and preserves. It coats each individual strand with a tough, viscous film that protects against corrosion, keeps wear at a minimum, and greatly lengthens service life.

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# TEXACO

LUBRICANTS AND FUELS  
FOR ALL INDUSTRIES

# LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

Published by

The Texas Company, 135 East 42nd Street, New York City

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Vol. XXVII

January, 1941

No. 1

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## Temperature Maintenance

**P**RODUCTION, in going to higher speeds, of necessity has had to go to higher pressures. In addition, higher temperatures are being experienced, all placing loads upon lubricants which are considerably above normal. It used to be that with increased speed the body or viscosity of a lubricant could be reduced. But when higher pressures prevail at temperatures approaching the vaporization point of certain lighter hydrocarbons, the entire problem must be reviewed. It may require a viscosity which would have been considered quite out of line in conventional service; or even the use of special temperature-resisting components in the lubricant. So it is fitting to study temperature as it affects lubrication on modern industrial machinery.

For virtually any petroleum lubricant there is a certain desirable temperature range within which it will function most dependably. The intricacy of the mechanism to be lubricated has a controlling influence upon this range. Usually it will fall within 50 degrees. This does not mean that beyond this range a lubricant may fail; our experience with the automotive engine is too vivid proof to the contrary. This same experience, however, has also indicated the value of temperature control as an adjunct to machine protection. As it is this latter which is of primary concern, and probably the chief reason for lubrication, methods of temperature control will be of interest.

In contrast with those operations which develop abnormally high temperatures, there are conditions which involve subnormal temperatures, viz., in mining and materials handling, also in refrigeration. So we must consider a conservative range of from 60 below in refriger-

ation to around 2,000 above in the glass and metal industries.

From a mechanical point of view both these extremes have been proved to be practicable and readily maintained, provided machinery and materials are designed and selected to develop complete coordination.

### PETROLEUM COOPERATES

Lubrication must be classified among materials. Not so many years ago it would have been impossible to operate machinery under the extremes which prevail today. Lubricants were not available because petroleum research had not progressed sufficiently to produce oils and greases of adequate pliability at low temperatures, and resistant to break-down at high temperatures. As this research was intensified, however, it developed some very interesting facts:

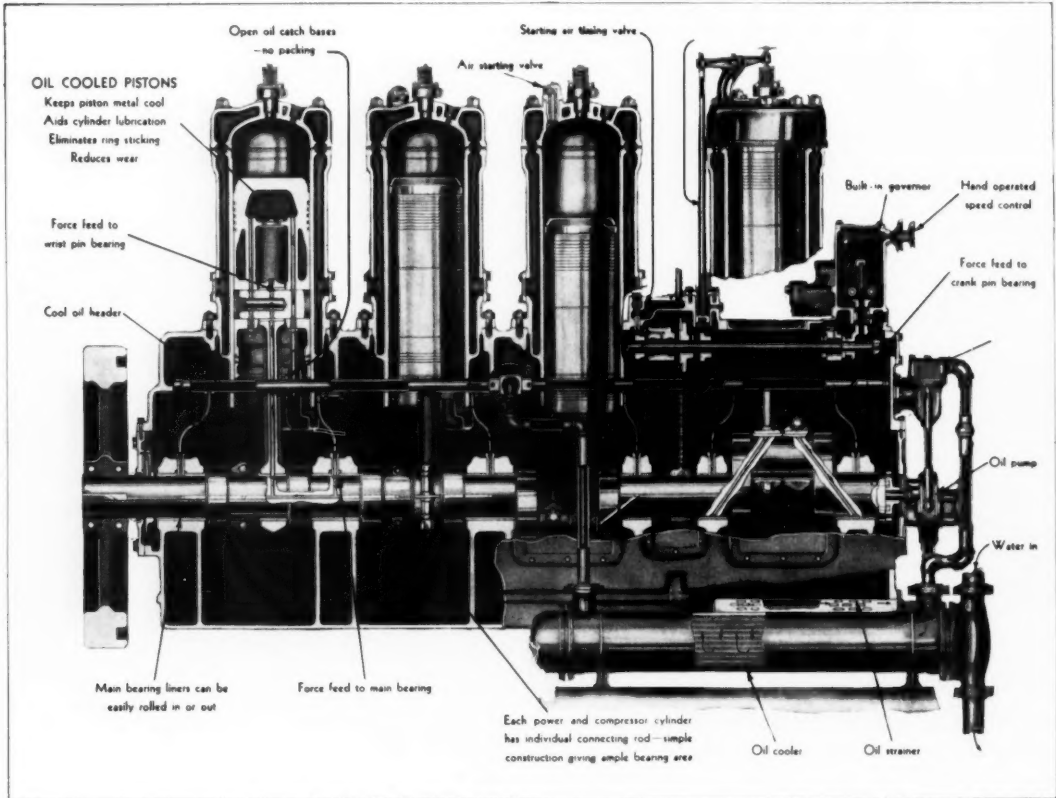
- (A) It proved that chemical stability, in the presence of certain refrigerants involving sub-zero operation, is probably the most important characteristics in an oil intended for refrigerating compressor lubrication, and
- (B) That close fractionation and removal of low boiling point hydrocarbons enables an oil to withstand high temperatures.

By incorporating these features in lubricating oils prepared for engine or compressor service, and for compounding with greases intended for higher temperature bearing conditions, means of temperature control could then be studied as an adjunct to lubrication rather than the reverse.

### Temperature Control

Temperature control can be accomplished by means of water, oil, steam or air. In other words, using a fluid or vapor which will conduct heat away from, or to, the parts in question.

condition with choke provision for obtaining a richer mixture when starting cold. Until the engine is properly warmed up the choke is a decided adjunct to smooth operation but during the interim an excess of fuel is used. Conversely, if the engine runs too hot this also



*Courtesy of Clark Bros. Co., Inc.*

Fig. 1—Sectional view of a Clark right angle gas engine driven compressor showing method of lubricating and cooling the piston, and subsequent cooling of the oil by water.

Water is most widely used for cooling purposes. In this capacity it is most familiar as an accessory to proper operation of the automotive engine. In industry it is widely used in Diesel engine and gyratory crusher cooling systems, in the inter-coolers of air compressors and as the coolant in oil circulating systems in the steel and paper mills. By maintaining a suitable difference between the inlet and outlet temperatures of the water the rate of heat transfer can be proportionately controlled; the lower the inlet water temperature the greater the control factor.

This is a most important item in cylinder cooling of the automotive engine as there is a definite relation to fuel combustion efficiency. The jacket cooling water must not be too cold otherwise incomplete combustion may occur, for carburetors are adjusted to the heated

affects combustion efficiency. This is why automotive engine builders have studied engine cooling systems so carefully, increasing the coverage area of the water jackets, and cooling system capacity to keep the cylinder walls and crankcase within an accepted temperature range regardless of atmospheric conditions.

We are not always dealing with conditions as ideal as the automotive engine, however, where temperature control can be definitely correlated to lubrication. There are many types of exposed mechanisms in contracting, materials handling and mining machinery where there is but little possibility for temperature control. Here the lubricant must bear the entire burden.

Obviously this burden would be reduced could the lubricants in question be kept within a suitable temperature range. But as it is im-

practicable to design for this in many mechanisms the cooperation of petroleum research has been enlisted in order to produce lubricants better suited to the expected operating conditions. Still there are limits set up by the very nature of the hydrocarbons which compose these lubricants. Beyond these limits the problem remains as one of mechanics, to be studied after the specific limits of the lubricants available have been established.

It must never be assumed that any particular lubricant is all-temperature resisting although some one is best adapted to the operating conditions in question. As we approach the ideal in this regard the load imposed upon the lubricant is reduced. On the other hand, where a wide range of operating temperatures prevails the viscosity range of the lubricants will be proportionately wide with the possibility of drag and internal friction at the lower end of the range and impairment of the film strength at higher temperatures.

### AIR AS A CONTROL MEDIUM

In the earlier stages of industrial and power machinery development, extremes of operating temperature were not as prevalent as are experienced today. So it was often practicable and economical to resort to air cooling by simply circulating fresh air to or around the mechanism to be cooled. When manufacturing went to higher speeds, heavier loads and more automatic methods of production, however, operating temperatures often increased due either to proximity of heated materials or actual operation. Then liquid cooling became a factor.

#### *Air Cooling Contingent Upon Circulation*

Air cooling has been most practicable on mobile machinery such as the automotive or radial type aircraft engine. In the former it has been almost entirely superseded however by water-cooling since this gives better control of engine temperatures especially at low speeds, also furnishing more reserve cooling. Furthermore, the added weight of the radiator, pump and cooling medium is not objectionable.

In the modern aircraft engine, however, dead load is a vital factor, for it is directly related to pay load. Furthermore, the aircraft engine operates under more constant air velocity conditions which are conducive to

more complete circulation around the fins which surround each cylinder, to result in adequate heat transfer. In other words draft either natural or induced is essential to satisfactory air cooling. Some types of stationary machinery also can be cooled by air but as the entire unit is exposed, oftentimes those parts which require cooling to assist lubrication are not subject to complete air circulation, with the result that heat transfer is not effected to the desired degree. Another way of looking at this is to state that the parts to be cooled should be preferably in the same plane with respect to the air stream in order that none of them shall be exposed to heated air from the others. The radial aircraft engine illustrates this idea most effectively.

### LIQUID COOLING

A variety of liquid coolants has been used in connection with industrial and power machin-

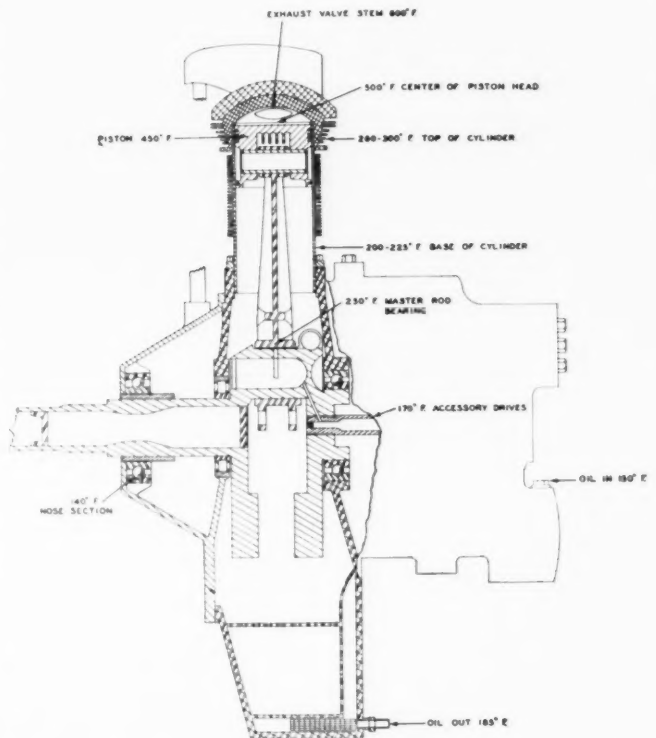


Fig. 2—Section of a typical air-cooled aircraft engine showing average temperatures at those parts where lubrication is important, or where the lubricant might be affected by improper cooling.

ery, their selection being dictated by machine design and products available. Hence it was that oil cooling of certain types of Diesel engine pistons was developed, using crankcase oil for cooling as well as lubrication.

More generally, however, the specific heat is a criterion. In other words, the ratio between the amount of heat required to raise the temperature of a unit weight of a material one degree to the amount of heat required to raise

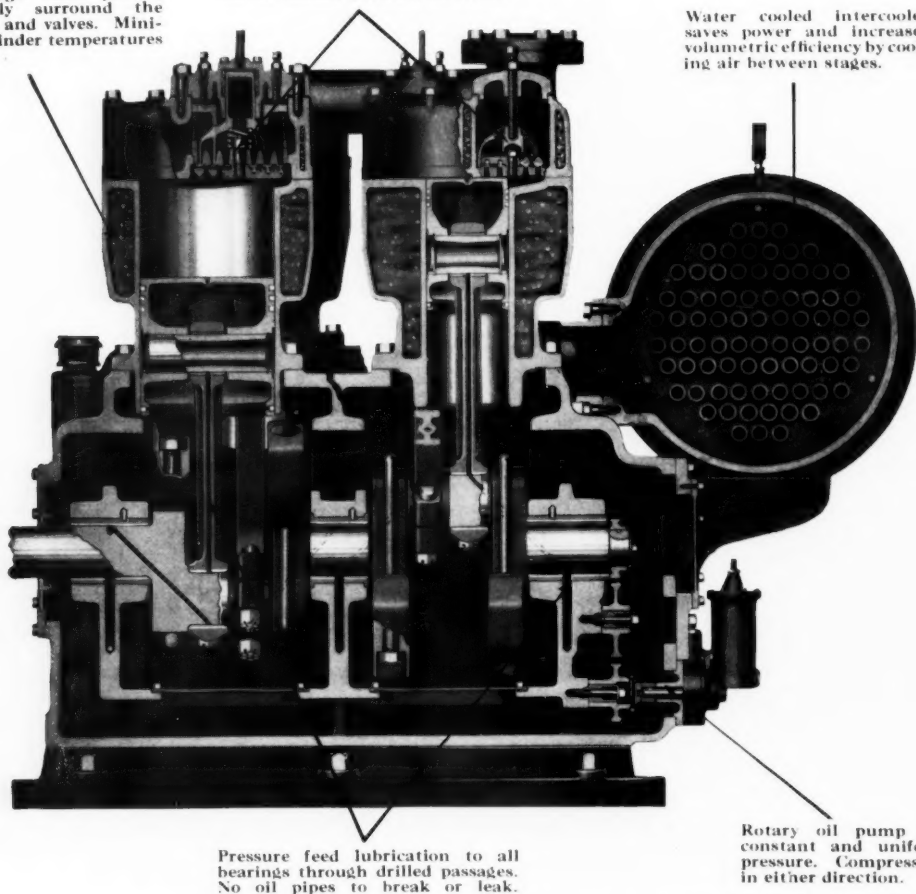
(3) Usually no precautions are necessary with regard to storage or disposal.

The desired results can be attained most dependably when water is circulated under pump pressure through suitable water jackets

Extra large water jackets completely surround the cylinders and valves. Minimum cylinder temperatures assured.

Cushioned inlet and discharge valves. Silent, durable, efficient.

Water cooled intercooler saves power and increases volumetric efficiency by cooling air between stages.



Pressure feed lubrication to all bearings through drilled passages. No oil pipes to break or leak.

Rotary oil pump assures constant and uniform oil pressure. Compressor runs in either direction.

Fig. 3—The Gardner-Denver vertical two-stage air compressor showing provisions for water cooling, and pressure feed lubrication.

*Courtesy of Gardner-Denver Company*

the temperature of a similar quantity of water one degree.

### Water

As water is taken as the standard and as all conventional liquids which may be used in lubrication cooling systems are possessed of lower specific heat, it is obvious that water is the most effective heat transfer agent of any of these liquids. Water is possessed of other advantages in that:

- (1) It is obtainable in virtually any quantity in most localities.
- (2) It is cheap and can be economically handled.

or cooling coils. It is also practicable, however, to make use of thermal properties and the natural tendency of warm water to rise in a circulating system. Certain older types of automotive cooling systems embodied this idea a number of years ago. The same principle is made use of in the heat exchange coils which are installed in gyratory rock crusher lubricating systems for preheating the oil prior to cold starting in low temperature service.

Water, however, is not without certain disadvantages, in that should leaks develop between the cooling and lubricating systems undesirable contamination of the lubricant by water would result.

The extent to which this might be detrimental to subsequent operation would depend upon the degree of refinement of the oil, the design of the machine and the readiness with which it can be flushed.

Water contamination in a steam turbine oil, for example, is very serious as it contributes to rust formation. So only the most carefully refined oils should be used. Obviously they must have the least possible tendency to hold water in suspension otherwise, in addition to rust, emulsification and subsequent agitation in the presence of air would cause sludge formation.

Sludge is non-lubricating and frequently of a sufficiently viscous and sticky nature as to lead to obstruction of oil lines, bearing grooves or other parts of the lubricating system. Sludge may interfere with lubrication, due to possible reduction in circulation of the oil. Sludge will also decrease the cooling ability of the oil. This is, of course, only a partial function of the lubricant, but if circulation is maintained at a sufficient rate it will materially aid in reducing bearing temperatures, particularly at the bearing surfaces where over-heating would be most

connection with some of the earlier developments of the automotive engine. The obvious purpose, of course, was to maintain engine temperatures at a more constant high level in the interest of promoting greater efficiency in fuel combustion, and thereby better economy. The idea, however, was never perfected to the point of receiving popular acceptance. The difficulty lay in the inability to coordinate engine design with low cost production.

Steam cooling, where a higher range of temperatures is desirable, could be likewise applied to certain industrial operations where oil might be impracticable due to carbonization or where water might flash into steam and cause pressure complications. One could visualize such an application in metal working machinery, in the cement mill and perhaps in oven or dryer design. By designing the cooling jackets or coils to carry the available steam pressure, and selecting the lubricant for attendant mechanisms so that the viscosity, carbon residue content and flash point will conform to the operating temperature range. This latter might conceivably be held to very narrow limits.

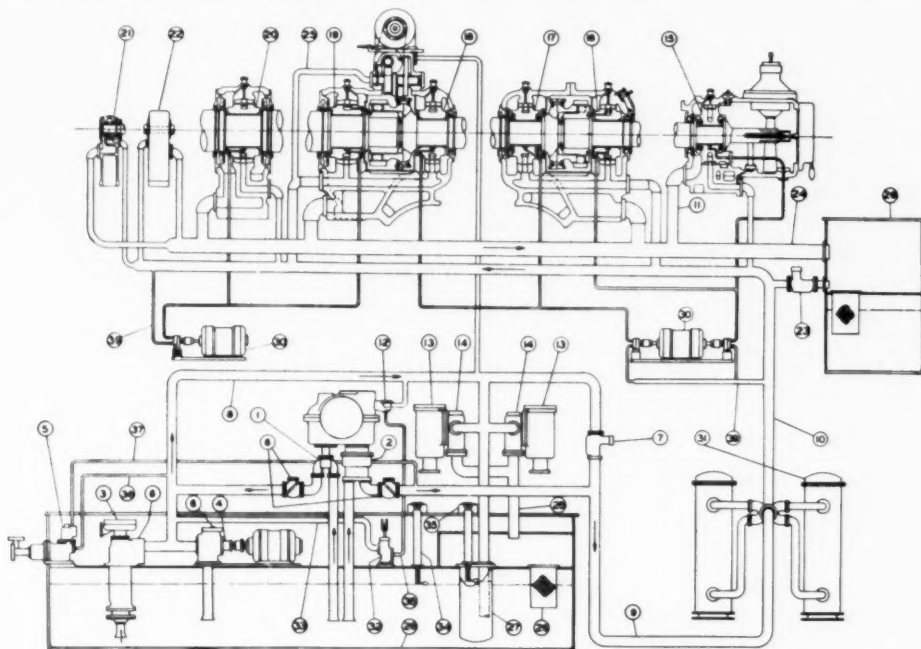


Fig. 4—Details of an Allis-Chalmers turbine oiling system showing the oil coolers (31); the bearing oil supply lines (9 and 10) to and from the cooler; and other parts essential to effective lubrication.

*Courtesy of Allis-Chalmers Manufacturing Co.*

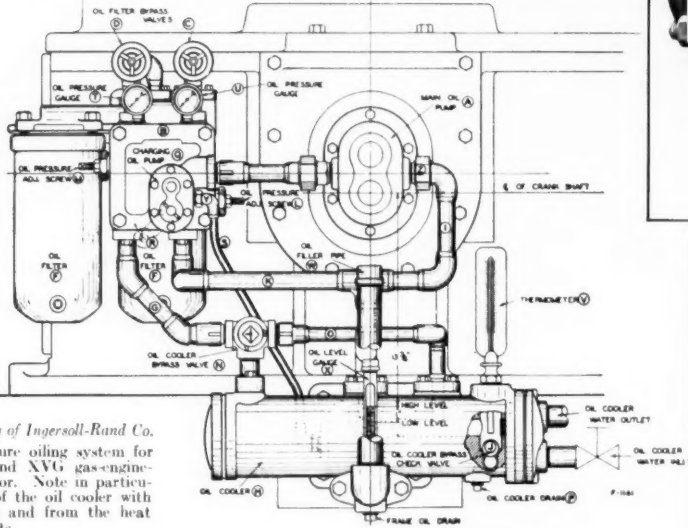
detrimental. In this the oil serves as an assistant to the cooling water in maintaining safe operating temperatures.

### Steam Cooling

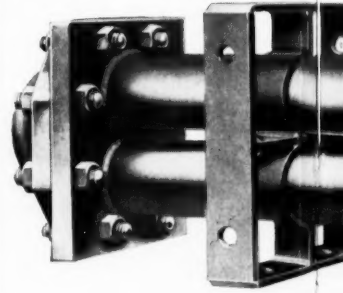
Steam has been used for cooling purposes in

### Oil Cooling of Diesel Engine Pistons

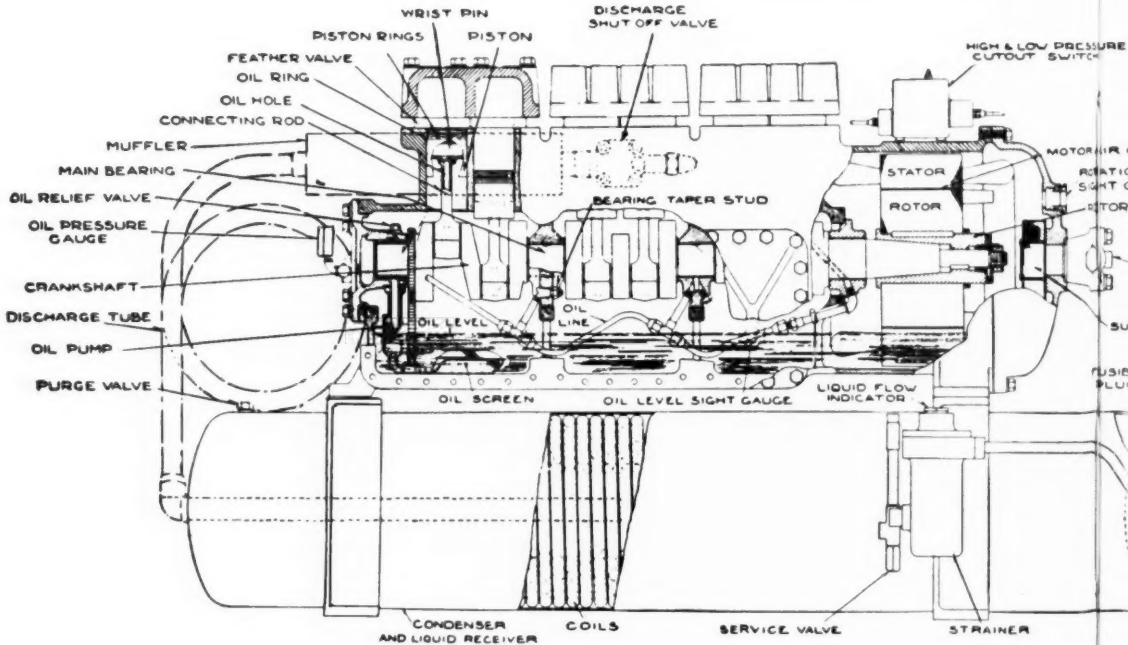
The development of the high speed Diesel and the adaptability of this medium of power generation to service comparable with the steam turbine, has required careful thought concerning efficiency in operation, positive



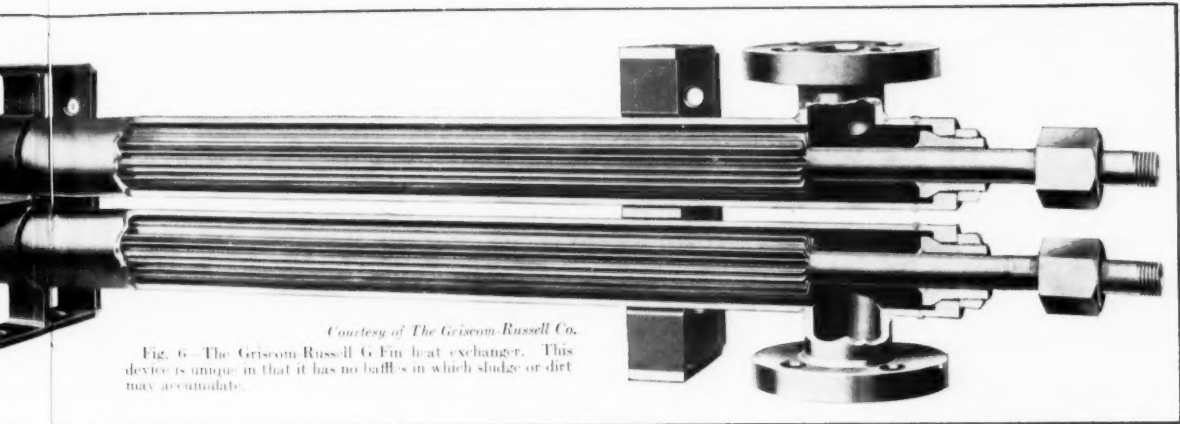
Courtesy of Ingersoll-Rand Co.  
Fig. 5—Pressure oiling system for an Ingersoll-Rand XVG gas-engine-driven compressor. Note in particular the details of the oil cooler with water piping to and from the heat exchange elements.



Courtesy of Westinghouse Electric & Mfg. Co.  
Fig. 7 (Below)—Details of the Westinghouse unit showing the method of using for refrigeration purposes. The motor is totally enclosed and it returns from the evaporator.



# LUBRICATION



Electric & Manufacturing Company of the Westinghouse air conditioning system of using "reon" gas for cooling purposes. The gas is fully enclosed and cooled by this gas as it passes through the motor.

PRESSURE SWITCH

MOTOR AIR GAP  
RELATION  
SPAT GAUGE  
MOTOR QUILL

SUCTION VALVE

SUCTION SCREEN

FUSIBLE PLUG

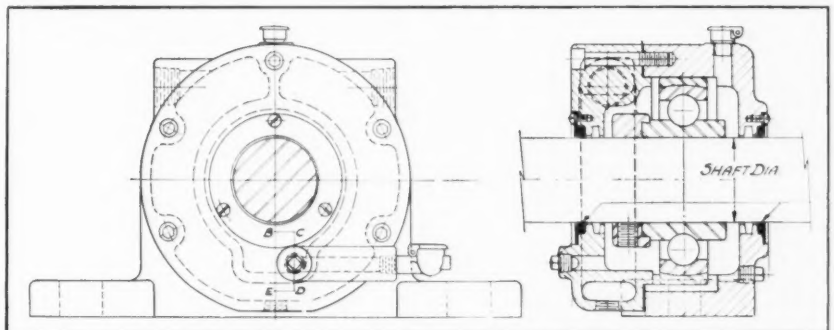
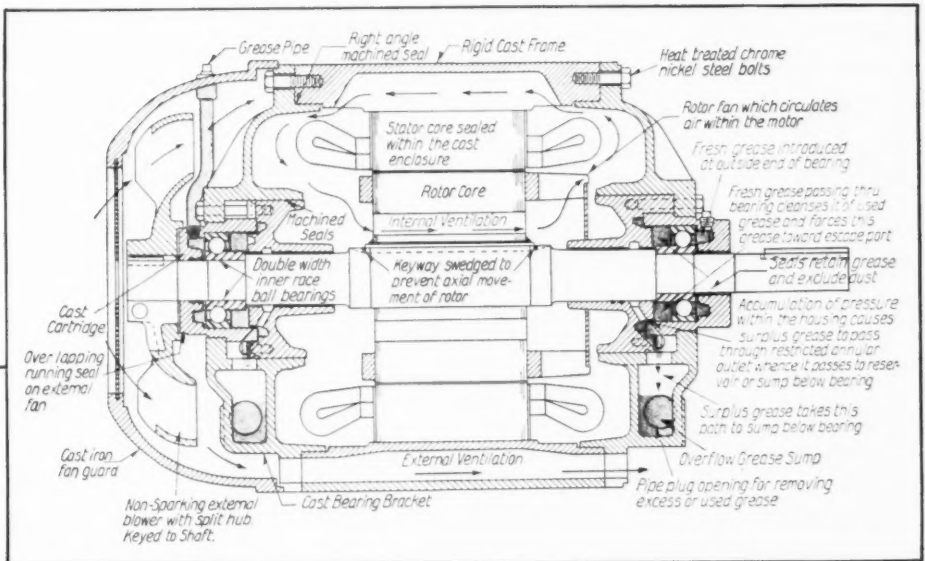
PRESSURE RELIEF CONNECTION

WATER OUTLET ON MANIFOLD

WATER REGULATING VALVE

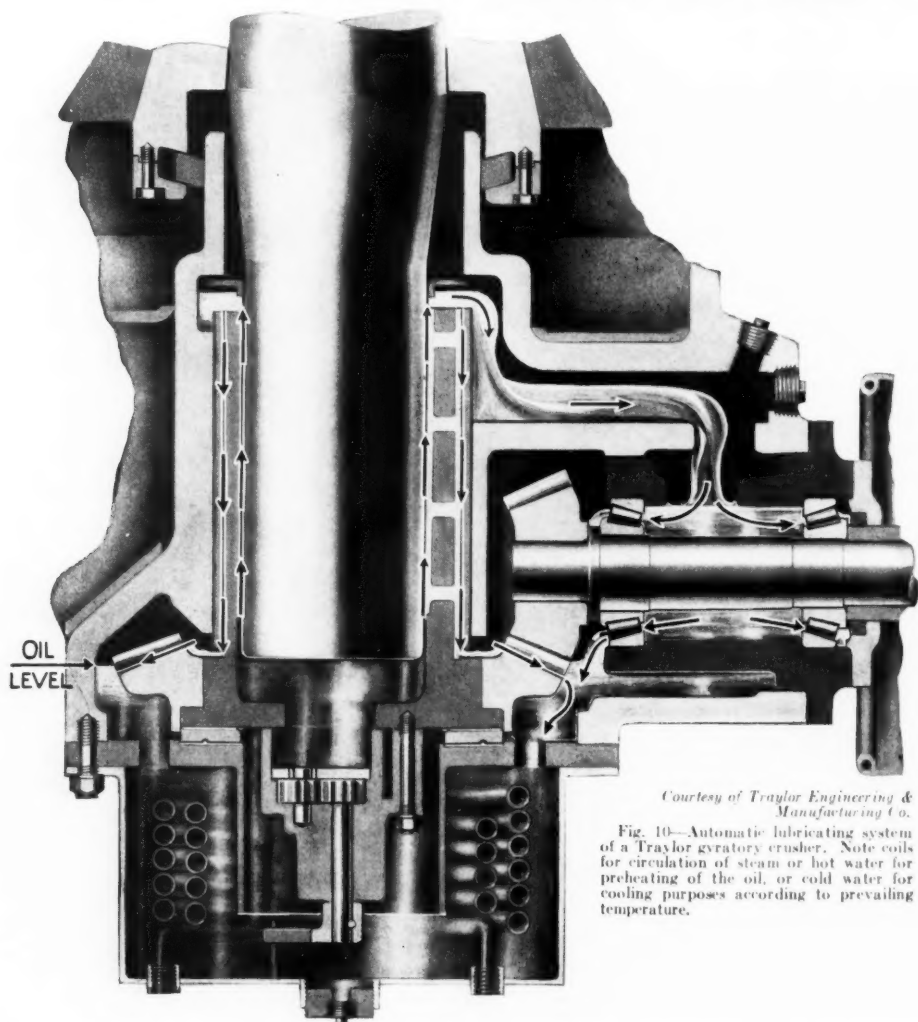
WATER INLET

SHUT OFF VALVE



lubrication and dependable cooling. Probably the most advanced idea has involved the possibilities of oil as a cooling medium for the pistons. There is a definite advantage to this thought wherever it can be practically applied

conditions. Well refined straight mineral oils possess quite satisfactory characteristics as heat transfer media in that they will have but little tendency to gum or develop heat resisting deposits, especially when subjected to wide



*Courtesy of T aylor Engineering & Manufacturing Co.*

Fig. 10—Automatic lubricating system of a T aylor gyratory crusher. Note coils for circulation of steam or hot water for preheating of the oil, or cold water for cooling purposes according to prevailing temperature.

in that lubrication is, in turn, protected. In brief, the Diesel designer along with the operating engineer is taking the science of lubrication more seriously than ever. Naturally it covers a multitude of conditions, both structural and operating; it requires considerable familiarity with petroleum lubricants; and by reason of the prevailing high temperatures the principles of heat transfer must be thoroughly understood.

Heat transfer is directly related to lubrication. It is obvious that in an internal combustion engine such as the Diesel, where cylinder walls and pistons are directly exposed to burning gases, lubrication of these surfaces must be carried out under most detrimental

temperature variations. Furthermore, they possess the distinct advantage in that, should leakage develop, the quality of the lubricant in the crankcase will normally not be materially lowered, especially if the oil which is used for cooling is of a sufficient degree of purity. In other words, oil cooling insures that lubrication will not be impaired due to possible development of non-lubricating sludges. Mineral oils, however, have a considerably lower relative cooling ability compared with water, due to their lower specific heat.

Protected lubrication is of material importance in the operation of the modern Diesel engine. Construction of virtually all the large

## LUBRICATION

high speed engines requires cooling of the pistons. This can, of course, be accomplished by either water or oil. Their relative advantages have already been mentioned.

Oil as a cooling medium, however, is limited

from the effect of pressure alone. Due to the inherently dangerous nature of hot oil, however, the utmost precaution must be taken to prevent leakage due to high temperature-effect on piping materials or fittings. Oil leakage

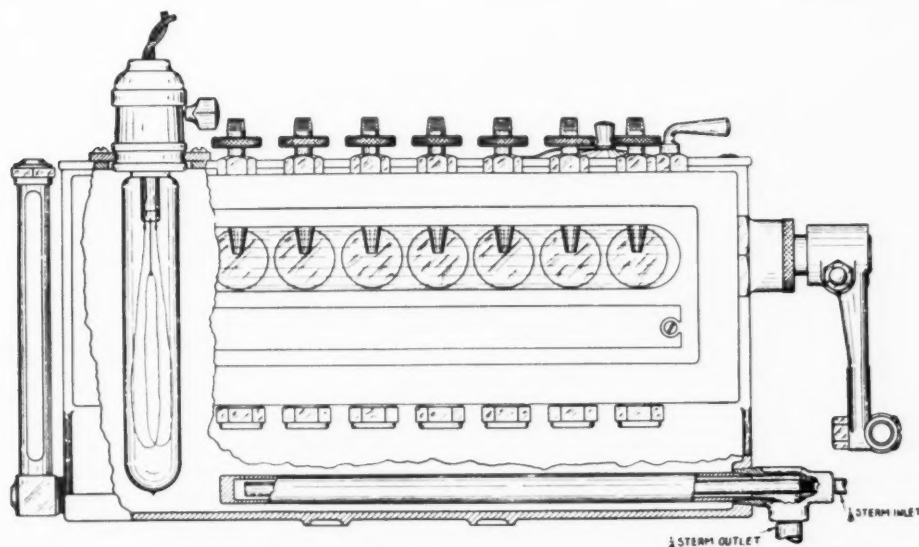


Fig. 11—Section of a Bowser automatic force-feed lubricator showing steam coils in the oil reservoir for preheating purposes.  
*Courtesy of S. F. Bowser & Co., Inc.*

by the design of the piston. This must be such as to insure continuous turbulence of flow within the cooling medium in order to prevent, as far as possible, the formation of heat-resisting films along the walls. Should such films develop, carbon deposits may be the ultimate result, especially at the more highly heated parts of the piston. To prevent this becomes a function of the designing engineer.

### Lubricating Oil Heat Exchangers

Lubricating oil heat exchangers being also of the fluid type can be adapted conveniently to use mineral lubricating oil as the cooling medium. This is especially helpful in service where leakage might impair the lubricant; viz., in turbine service where water leaks would cause emulsification and rusting. This attaches a distinct advantage to oil cooling even though oil may not give as much cooling effect as water.

Conversely, oil has proved to be adaptable to process heating instead of steam or hot water. The usual conditions of application enable economical construction, for low pressures are an adjunct, along with temperatures ranging up to perhaps 500 degrees Fahr.; features which permit the use of standard equipment and fittings. In other words, low pressure operation requires no extra precaution to prevent leakage, which might result

coming in contact with certain types of materials being processed might also cause damage through staining or discoloration.

The use of hot oil applied via a suitable circulating system to a lubricating system also requires precaution against leakage, especially if the grade of oil used for preheating is lower in quality than the lubricating oil involved. As gasification is objectionable in an oil heating system, the design must be prepared so as to prevent accumulation of gas. This can be accomplished by means of a suitable vent attached to an expansion tank. Elimination of gas accumulations prevents pressure build-up and assures of more uniform heat transfer.

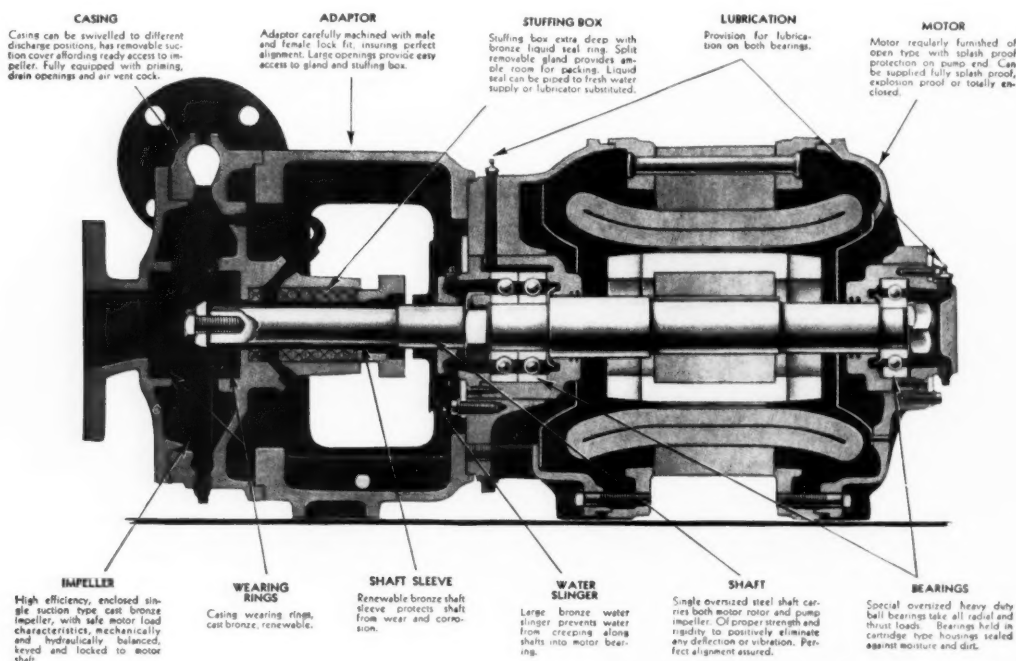
### METHODS OF AIR COOLING

Stationary materials or machinery can be cooled by air most effectively by locating in a stream of fresh cool air. This air stream can be maintained and controlled with regard to intensity and velocity by means of an electric fan or blower. In turn, its temperature can be regulated as desired. We have already mentioned how the design of the radial aircraft engine provides for air cooling. Now let us see how the modern research laboratory does the same thing in studying automotive equipment on the chassis dynamometer,—a case of mobile equipment operated in stationary position. It is known that wind velocities comparable to

road service can be attained by operating a centrifugal fan or blower and blowing air over the front of the car under test. The operating speed of the fan with respect to the speed of the traction drums of the dynamometer on

## CIRCULATION OF FLUID COOLANTS

Circulation of cooling water or oil at uniform velocity commensurate with the rate of heat transfer desired can be maintained most effectively by use of pumps in order to develop



Courtesy of Goulds Pumps, Inc.

Fig. 12—A Goulds centrifugal pump showing essential details of construction, also provisions for bearing lubrication.

which the car runs is such that at any car speed the velocity of the air striking the front of the car will be very nearly the same as the actual speed the car is making on the drums. This assures cooling of the radiator and especially the engine oil pan equivalent to that of running at the same speed on the road.

To maintain suitable temperature control of the air used for cooling purposes, provision must be made to deliver this air at any atmospheric temperature up to 130 degrees Fahr. In operation, the air passing to the chassis dynamometer fan can be taken directly from outdoors. It is then re-circulated through a grating in the floor, and heated, if necessary, prior to passage to the fan.

An additional provision for affording positive control of air is made possible by installing two sets of sliding doors, one of which can be used to regulate the amount of air re-circulated through the heating element, the other being arranged to open the fan suction directly to the outside fresh air. Both these sets of doors can be adjusted by the operator at the control station, at which point the temperature of air being directed against the car is also indicated.

rapid circulation and to enable constant renewal of the cooling film essential to heat transfer on the surfaces to be cooled. Furthermore, rapid circulation with adequate turbulence reduces the possibility of formation of stagnant films which may readily serve as insulation. Another means of preventing this is to employ cooling coils or jackets with comparatively smooth surfaces.

The type and size of the pump depends upon the size of the installation and the volume of coolant to be circulated. Under general conditions of industrial plant or engine operation, the gear, rotary or centrifugal pump is used. The reciprocating piston or plunger pump is, of course, also adaptable, but as it normally requires steam for its operation it is but little used in connection with oil cooling.

Circulating pumps can be driven either directly by the machine which they are to serve, by an independent electric motor or some other means of power transmission. In the automotive engine, it is customary to use a gear pump, driven by chain connection from the main shaft. Where industrial bearings are involved, however, or where a more consider-

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able volume of cooling media must be handled, independent means of drive is frequently adopted. In marine steam service, the reciprocating steam pump is widely used.

Rotary motion as embodied in the gear,

under variable pressure and volume conditions. They must always be designed to operate free from air leaks, however, otherwise there will be a reduction in efficiency. Furthermore, the pump discharge must be of such a diameter as

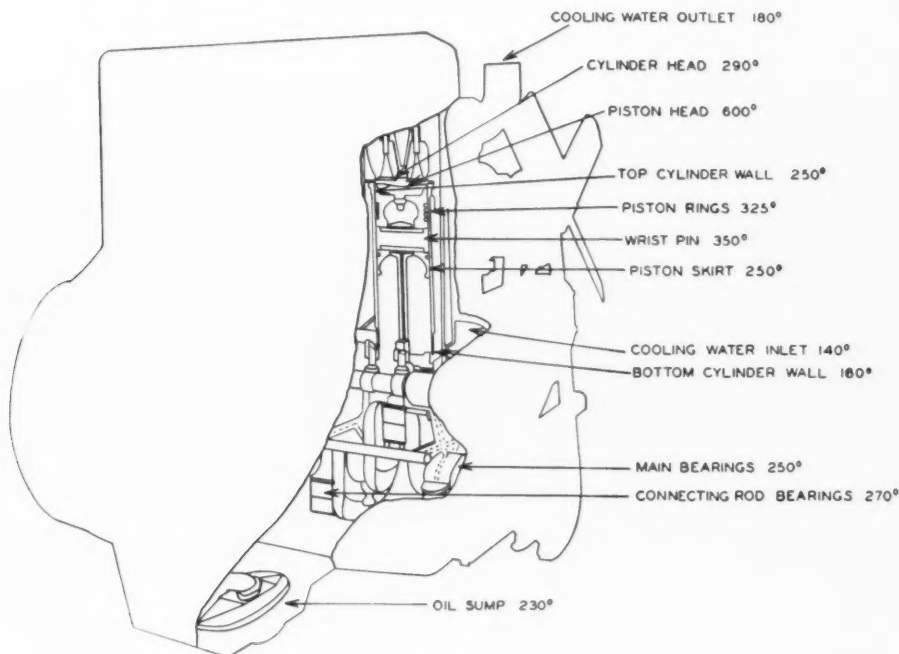


Fig. 13—Some details of a heavy-duty automotive type engine showing average temperatures at those points where lubrication is important, or where the lubricant might be affected by improper cooling.

screw type or centrifugal pump is distinctive in that it requires no valves, springs or other small parts to wear out or become inoperative. Furthermore, there are normally no internal parts that require lubrication. In other words, where a cooling water pump, for example, may be installed externally, the only parts to be lubricated will be the bearings. With an internally installed gear pump, on the other hand, lubrication is brought about from the machine itself.

### Centrifugal Design

A centrifugal pump requires one or more rotors or impellers which revolve in a fixed plane within a suitable air-tight casing. The fluid to be handled is received at the hub or center of the impeller, pressure being acquired as it is impelled outward to the circumference by means of suitable blades. Fixed discharge valves are used similar to stationary nozzles, or a suitable spiral casing is employed. Volute pumps are of this latter type. Centrifugal pumps are of definite value where a considerable volume of cooling fluid is to be handled

to insure the delivery of the fluid with a minimum of friction, the operating speed must be commensurate with the pumping head and there should be a minimum of sharp bends and elbows in any piping involved.

### Rotary Pumps

The rotary design involves two rotating elements, consisting of gears, screws, pistons, impellers or cycloids. The principle is quite akin to that of the geared pump, the matter of teeth or lobes being the criterion. The most common type of such a pump is the geared device as used in connection with the automotive engine. While it serves chiefly as a lubricating pump it is important to remember that the volume of oil which it delivers to the moving parts also insures a certain amount of cooling. This same result is obtained in the lubrication of certain types of steam turbines using a pump of similar construction.

### Pump Lubrication

As pumps require lubrication, the bearings or other mechanisms must be studied from the

viewpoint of their location. Where a pump for cooling purposes is built into the machine which it is to serve, it will normally be designed for the handling of oil, the function of which is both to serve as a lubricant and a coolant. At the same time, this oil serves to lubricate the pumping elements.

Where either a centrifugal or rotary type of pump is designed for the handling of cooling water, it will be installed adjacent to the main machinery, but usually driven directly therefrom through gear, chain or belt connection. In pumps of this type it will, of course, be essential to lubricate the bearings, for the pumps cannot be expected to function effectively as an aid to lubrication if they are not, in turn, properly lubricated.

Bearing design may vary to some extent, according to the type of pump and its intended service. In turn, one may therefore be confronted with specific problems according to the operating conditions. They require serious consideration and cannot be passed over as mere instances of ring oilers, ball bearings, etc., or plain babbitted bearings served by oil or grease cups.

### *Ring Oiling*

The ring or collar oiler is widely used on horizontal jobs or for oil circulation to the bearings of centrifugal pumps. Its specific advantages include economy, cleanliness, and ability to maintain uniform and automatic lubrication requiring little attention.

The design of a typical ring or collar oiler comprises a bearing housing which is built with a reservoir and a slot of sufficient width and depth to permit one or more rings or collars suspended from the shaft to revolve therein. When the shaft revolves, these elements being subject to rotation, carry a flood of oil to the top of the shaft from whence it is able to flow into the bearing oil grooves and throughout the clearance space. In this way complete distribution is effected.

After the oil has passed through any such bearing, it flows out to the end or ends of the housing through a suitable return chamber which is part of the bearing housing, back to the oil reservoir below.

Ring oilers are not usually recommended for bearings below two inches in diameter, especially where high speeds are involved, due to occurrence of excessive slippage of the rings, and the possibility of oil foaming where reservoir capacities are limited and aeration may be restricted.

This is one of the simplest yet positive methods of lubrication whereby the bearings are flooded with a considerable excess of oil over the amount that would theoretically be

necessary to furnish the requisite oil film. By flooding the bearing with oil the latter serves not only as a lubricant, but also as a cooling medium to carry away part of the frictional heat developed, thereby reducing the temperature of operation. If the oil reservoir in the base of the bearing has been properly designed and is of sufficient capacity, this over-heated oil will then have ample opportunity to become cooled by contact with the reservoir walls after each circulation. This flood of oil will also serve to wash out any grit, dirt, dust or metallic particles that may have gained entry, thereby another cause of wear will be largely eliminated. On account of this washing action of the oil, however, the reservoir will gradually tend to accumulate a certain amount of sedimentary deposits. Therefore, it should be flushed out and cleaned at intervals, the old oil being replaced with fresh lubricant.

### *Ball and Roller Bearings*

Ball bearings or sometimes those of the roller type are also employed on circulating pumps. Probably the most noteworthy of the smaller installations involves the automotive engine cooling water pump. Developments in design have taken full advantage of the principle of rolling motion, and the possibility of planning for long-time lubrication with the need for minimum attention. Here, however, it is always essential to remember that one of the chief functions of the lubricant is to prevent corrosion of the highly polished surfaces. Wherever possible, the housing should be both water-tight and oil-tight; the one to prevent entry of water, the other to prevent loss of lubricant and perhaps subsequent damage to the bearing.

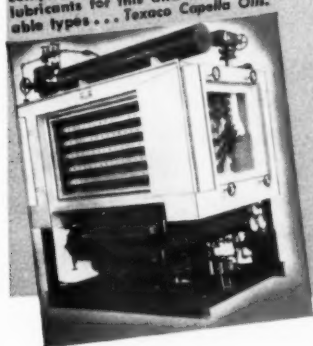
Wherever leakage is possible, a grade of light to medium grease should be used which will have just enough body to cause it to remain in the bearing housing. Lubricating fittings are often eliminated on such bearings, it being customary to charge or fill the housing and raceways with the proper grade of lubricant, through a suitable opening or fitting which can be effectively sealed or plugged during subsequent operation to prevent the lubricant from flowing out.

In general, one charge of oil to a roller or ball bearing equipped with an oil-tight housing should last for a period of several months. Where grease is required, however, it should be renewed according to the extent of seal which is maintained. The pre-lubricated, sealed-type bearing should function successfully for an extended period of time. The frequency of re-lubrication being dictated by the manufacturer's recommendation and experience in operation.

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